LWG
LOWER WILLAMETTE GROUP

FRAMEWORK FOR EVALUATING EXPOSURE TO THE BENTHIC COMMUNITY AND HUMANS FROM CHEMICALS TRANSPORTED IN G ROUNDWATER

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Figures and Tables (separate document)

1.0 Introduction

The Portland Harbor Superfund Site RI/FS Programmatic Work Plan (Work Plan) (SEA et al. 2003) identifies groundwater as a potential source of chemicals to the initial study area (ISA). In the ISA conceptual site model (Figure 5-1 of the Work Plan), groundwater is identified as a possible pathway for transport of chemicals between upland sites and the Willamette River. Chemicals of interest (COIs) are present in shallow groundwater underlying a number of upland sites along the ISA. The Upland Groundwater Data Review Report (GSI 2003a) summarizes the distribution of COIs in groundwater at upland sites between RM 2 and RM 11 of the Willamette River. Because the river is the primary discharge point for groundwater from upland sites, it is important to determine whether these COIs may migrate to the Willamette River at concentrations that may pose risks to human or ecological receptors utilizing the river.

This document presents an analysis of potential exposure pathways for groundwater and a framework to:

- Determine which groundwater COIs may pose risk to human and ecological receptors, and
- Evaluate locations where additional field data are needed to assess risks associated with COIs in groundwater in the baseline ecological and human health risk assessments.

The proposed process is a screening-level evaluation designed to identify whether additional data are needed to adequately assess potential exposures and associated risks to receptors in the ISA. The proposed process will result in identification of locations in the ISA where a complete pathway exists for exposure of human or ecological receptors to COIs in groundwater, and where additional data are needed to assess risks from these exposures. The contribution from chemicals of potential concern (COPCs) in groundwater to overall risk will be presented in the baseline ecological and human health risk assessments for the ISA.

For humans, the potential exposure medium is the seep water above the shoreline in human use beach areas. For ecological exposure, benthic communities are the ecological receptors that potentially could be the most impacted from COIs transported in groundwater. These benthic communities may be exposed to chemicals in sediments or porewater that were transported via groundwater to the biologically active zone. In the ISA, this zone is defined as the upper 30 cm of sediments based on agreement with EPA and Oregon Department of Environmental Quality (DEQ).

This framework document includes descriptions of the following procedures to be

used in evaluating exposure to chemicals in groundwater:

- Identification of groundwater transport mechanisms that result in potential exposure pathways to human or ecological receptors
- Compilation of a set of groundwater COI data for use in the evaluation of exposure to human or ecological receptors
- Selection and/or derivation of ecological and human health risk-based screening values
- Comparison of the ecological and human health screening values to COI concentrations in groundwater potentially discharging to the ISA to identify groundwater COPCs
- Selection of two suitable sites for pilot studies to further evaluate the potential exposure in the biologically active zone.

If this evaluation indicates that complete pathways exist for exposure of human or ecological receptors to COIs in groundwater, further evaluation of the contributions to risks from those pathways will be conducted as part of the RI, including collection of point-of-exposure data during Round 2B, if necessary. The pathway evaluation and point-of-exposure data will be incorporated into the ecological and human health risk assessments for the ISA. The risk assessments will identify whether COPCs in groundwater contribute to risks to either human or ecological receptors in the ISA. Locations where COPCs in groundwater discharging to the Willamette are determined to significantly contribute to risks will be referred to DEQ for evaluation of source control measures and the information will be used to assess remedial alternatives for the Portland Harbor FS.

It is not within the scope of the Portland Harbor RI/FS to implement formal risk assessment protocols for groundwater at each facility along the ISA. Extensive analyses of upland groundwater data are being or have been conducted as part of baseline risk assessments at individual sites under DEQ cleanup programs.

2.0 Groundwater Transport Mechanisms

Four potential groundwater chemical transport scenarios relevant to the Portland Harbor remedial investigation and feasibility study (RI/FS) have been identified in Section 5.1.3 of the Work Plan (SEA et al. 2003). These scenarios describe the mechanisms by which chemicals are transported in groundwater and may result in complete exposure pathways to ecological or human receptors. The four scenarios (modified from the Work Plan to more specifically describe the transport scenarios as they relate to human or benthic community exposure) are described below:

1. **Groundwater containing COIs from an upland source flows through sediments impacted by a different source or release** — COIs that are transported in groundwater that discharges to river sediments partition between sediments and porewater. In this scenario, groundwater containing COIs passes through sediments contaminated by separate upland, over-water or upstream sources. The chemicals originating in the groundwater may, or may not, be different than those in the sediments and may interact in several ways including: (1) groundwater COIs may partition from groundwater to sediment, (2) groundwater COIs may not interact with the impacted sediments and will eventually discharge to the river, and (3) COIs originating in groundwater may mobilize chemicals sorbed to sediments through cosolvency effects and transport them in the dissolved phase to potentially contaminate cleaner sediments nearer the surface, or cause porewater-related impacts within the biologically active zone.

   The potential impact to sediment and porewater depends mostly on the concentration(s) of the COIs in groundwater, the groundwater flux rate, the affinity of each COI for sediments, and the organic carbon content of the sediment (among many factors). The greatest impacts to sediments and porewater are likely to occur either where a non-aqueous phase liquid (NAPL) is transported to the river, or where there are high COI concentrations in groundwater discharging to the sediments.

2. **Surface seepage of groundwater containing COIs** — This scenario refers to shallow groundwater containing COIs that discharges in a seep from the bank above the water line and then flows to the river as seep water. The primary relevance of this scenario for the ISA is potential exposure to humans in human use beach areas.

3. **Groundwater containing COIs from an upland source flows through sediment not impacted by a separate source or release** —In this scenario, it is assumed that

the sediment has not been impacted by a separate source; i.e., the sediment is either not impacted by COIs or is only impacted by the groundwater COIs identified from the adjacent site. In this case, cosolvency effects or risks from other chemicals in sediment are insignificant. The primary relevance of this scenario for the ISA is as a mechanism of recontamination to sediments at locations where sediment capping or removal is implemented (after unacceptable risk has been defined in the baseline risk assessment), or from a porewater standpoint for COIs that are less likely to partition to sediments.

Clean groundwater flows through contaminated sediments (no upland source of groundwater COIs) — In this scenario, chemicals present in sediments may partition to clean groundwater flowing through the sediments toward the river. Some chemicals may then re-partition to the shallower sediments further along the flow path and/or potentially cause dissolved-phase impacts to porewater or surface water. This scenario is also a potential mechanism of contamination to overlying clean sediments (if in a depositional area) or a sediment cap. The impact of this scenario depends on the partitioning characteristics of the chemicals in question, the characteristics of the sediments, and groundwater flux rates among other factors.

Each of the above transport scenarios will be discussed in terms of application to the risk-based screening process in Section 5.

3.0 Compilation of Groundwater COI Data Set

This section describes the process and rationale for selecting upland groundwater COI data that will be compared to protective risk-based screening levels to identify locations where COIs in groundwater may contribute to human health or benthic risk in the ISA, and to identify where additional data are needed to further assess risk from the groundwater exposure pathway.

3.1 Selection of Upland Sites for Inclusion in Groundwater Exposure Evaluation

The Upland Groundwater Data Review report (GSI 2003a) identified the following three groups of sites with regard to the potential for groundwater COIs originating from those sites to discharge to the ISA:

1. **Group A**— Nineteen sites where COIs in groundwater have either been confirmed to discharge to the river, or have a reasonable potential to discharge.
2. **Group B**— Eighty-fivesites where the potential for groundwater COIs to reach the river cannot be determined based on available data.

3. **Group C—** Nine sites where site-specific groundwater data indicate with a high degree of certainty that COIs in groundwater either are not present or are not likely to reach the river.

The criteria used to identify Group A sites where upland groundwater containing COIs is known to discharge to the ISA or has a reasonable potential to discharge include any of the following:

- A record in DEQ files that a sheen has been observed in the river, or other visual indication that COIs present in groundwater are discharging to the river
- Frequent detections of COIs in groundwater samples collected adjacent to the riverbank
- Data indicating the presence of detectable concentrations of COIs in groundwater samples collected at or below the shoreline
- NAPL or detections of COIs in groundwater that intersect man-made or natural preferential pathways that lead to the river
- NAPL or detections of COIs that are not adjacent to the riverbank, but in a location from which groundwater transport to the river is plausible

The available data at most Group A sites are not sufficient to confirm impacts to sediments from groundwater COIs discharging to the river. Group A sites are identified in Sections 4 and 5 of the Upland Groundwater Data Review Report (GSI 2003a) and listed below in Table 3-1.

Table 3-1
Group A Sites*
Portland Harbor RI/FS

Site Name	ECSI #
ARCO Bulk Terminal	1528
ATOFINA Chemicals	398
Cascade General (Portland Shipyard)	271
Foss Maritime/Brix Marine	2364
Gasco (NW Natural, Koppers, Pacific Northern Oil)	84
Gunderson	1155
Kinder Morgan Linnton Terminal (GATX)	1096
Mar Com	2350
Marine Finance Corporation (Hendren Tow Boats)	2352
McCormick & Baxter Creosoting	74
Mobil Oil Terminal	137
Oregon Steel Mills	141
Port of Portland - Terminal 4, Slip 3 (UPRR pipeline)	272
Premier Edible Oils (Schnitzer Investment)	155
Rhone Poulenc (Aventis Crop Science)	2013
Triangle Park (Riedel Environmental)	277
UPRR Albina Railyard	178
Wacker Siltronic	183
Willbridge Bulk Fuel Facility **(Chevron, Shell, Conoco/Phillips)**	1549

Notes:

* = Group A sites from the Upland Groundwater Data Review Report, River Mile 2 – 11, Lower Willamette River (GSI, 2003a)
ECSI number: DEQ Environmental Cleanup Site Inventory number

Group B sites will not be evaluated using this process because the data at these sites are insufficient to make a determination with reasonable certainty that an exposure pathway is complete. The characterization of Group B sites is the responsibility of upland property PRPs under DEQ cleanup programs. If new DEQ data indicate that groundwater COIs at a Group B site are confirmed to discharge to the ISA, or have a reasonable potential to discharge, then that site may be re-categorized as a Group A site and the data from the site may be assessed using the screening levels developed

for this process.

Group C sites, which are sites where groundwater COIs are not present or are unlikely to reach the ISA, will not be considered further for evaluation of potential groundwater contributions to risks as part of the Portland Harbor RI/FS.

The process described in this document will be applied only to selected Group A sites because these sites represent areas where impacts to sediments and porewater from COIs transported by groundwater would be most evident. If adequate data become available, Group B sites that can be re-categorized as Group A sites may also be considered for evaluation using this process.

3.2 Selection of Groundwater COI Data for Assessing Group A Sites

This section describes the criteria and rationale for developing the groundwater COI data set to be used for the comparison with screening levels. The objective is to identify COI data that, of the data available, are most representative of groundwater COI concentrations that could reach the river. The following subsections present the process for selection of groundwater COI data for each Group A site.

3.2.1 General criteria and rationalefor data selection

The process for compiling and selecting groundwater COI concentrations for comparison to risk-based screening levels will include the following steps:

1. Review the most recent groundwater monitoring and investigation data available for each Group A site. Most recent data may include the past two years of monitoring data or the most recent investigative data at a given site.

4. Develop a list of all COIs detected in groundwater at a site. COIs are defined as chemicals that have been recently detected in upland groundwater and have not been screened relative to potential impacts to the ISA using risk-based criteria. Select well locations based on which wells are: 1) adjacent to the river, and 2) considered most representative of groundwater COI concentrations at the groundwater-surface water interface in the vicinity of the ISA based on evaluation of site-specific hydrogeologic considerations. The factors used for this assessment include:

    - The extent to which the spatial distribution of COIs in groundwater is characterized both laterally and vertically.
    - The locations of the chosen groundwater data collection points near the river relative to the source(s) of groundwater COIs and groundwater flow direction variations
    - The presence and status of any groundwater source control measures

5. Identify the data for each COI detected in groundwater at the monitoring point nearest the river. If a given COI is not detected at a monitoring point adjacent to the river downgradient of where it has been detected at a site, the minimum detection limit for that COI will be listed as the concentration. For additional detail regarding how nondetected analytes will be assessed, please refer to Section 5.1.

The criteria and rationale for each step of the process outlined above are summarized below:

- **Recent data**—Recent data better reflect the current status of upland groundwater COIs relative to the river, providing the most representative starting point for assessing exposure from discharge of groundwater COIs to the ISA. The COIs detected recently in groundwater are typically a reflection of the historical presence of COIs with the effects of transport, transformation, and attenuation processes superimposed.
- **Distance from river**—Groundwater monitoring points within 300 ft laterally of the Ordinary High Water Level (OHWL; equal to +15.7 ft CRD[1]) will be considered adjacent to the river for the purposes of this evaluation. Several practical considerations support the use of this distance:
  - Most sites do not have groundwater COI data at the shoreline or in the water. At a number of sites, 300 ft from OHWL is the minimum practical distance from the river for installing groundwater monitoring points by the conventional drilling methods typically used at most of the sites (e.g., hollow-stem auger or push-probes), due to the presence of embankments, retaining walls, marine facility structures and riprap.
  - Embankments or bluffs where seeps are present at some locations are within several hundred feet from the river's edge even at the OHWL.
  - Use of groundwater COI data from monitoring points located up to 300 ft of OHWL provides an added level of conservatism to the screening of the data, because concentrations of COIs can be expected to decrease further down the flow path toward the river.
  - The 300-ft distance is of an appropriate size to account for small-scale variability and uncertainties with regard to plume geometry and flow direction.
- **Monitoring points**—Monitoring well data are preferred over push-probe data because monitoring well data are typically more representative of the actual concentrations of COIs being transported in the dissolved phase by

groundwater. Data from more than one monitoring point may be considered for each COI, depending on the vertical and horizontal distribution of plumes and the site-specific hydrogeology. At sites with multiple wells within the same aquifer, the wells closest to the river will be used. Dissolved metals concentrations are preferred over total metals concentrations regardless of whether the monitoring point is a well or a push-probe.

- **Data density**—Data from the past two years of monitoring and/or the most recent investigative phase will be reviewed. The selected monitoring point for each COI will be evaluated with regard to how well the concentration(s) of COIs detected are anticipated to represent the concentrations in groundwater nearest the river. The evaluation of representativeness of the data from that monitoring point will be based on: 1) review of data from the well for several monitoring events to assess temporal variability (if available), and 2) review of site-specific hydrogeologic factors to assess the location of the monitoring point relative to the plume geometry. The rules for selecting COI concentrations are summarized in detail in Section 5.1.

3.2.2 Non-aqueous phase liquids

Dense non-aqueous phase liquids (DNAPL) or light non-aqueous phase liquids (LNAPL) have been detected in monitoring wells recently or in the past at 11 of the 19 Group A sites. NAPL has been detected in groundwater within 300 feet of the OHWL at nine of these sites. Standard practice for groundwater sampling is to not collect groundwater samples from monitoring wells containing NAPL because resultant analyte concentrations are generally highly variable and are not representative of either aqueous-phase COI concentrations in the aquifer or of the NAPL itself. Consequently, monitoring wells nearest the river that contain NAPL likely have not been sampled recently, and concentrations of COIs in the monitoring well nearest the river that does not contain NAPL may be relatively low and not necessarily representative of potential exposure to receptors from the NAPL. At these locations, the presence of NAPL near the river will be identified and evaluated qualitatively with regard to the nature and extent of the NAPL, as well as the potential of the NAPL to reach the ISA. Presence of NAPL or other obvious sheen will be addressed using the Portland Harbor Joint Source Control guidance document (currently under development).

4.0 Derivation of Groundwater Screening Levels

This section describes the process used to derive benthic community and human health groundwater screening levels (SLs). Section 4.1 describes the process for

selecting SLs for protection of benthic organisms, and Section 4.2 describes the process for developing SLs for human health.

4.1 Ecological Screening Levels

Effects-based acute (i.e., short-term and lethal) and chronic (i.e., long-term and sublethal) screening levels (SLs) will be used to identify groundwater COPCs for exposure of ecological receptors to COIs transported via groundwater pathways. For the purpose of this assessment, the following process (Figure 1) will be followed for identification of SLs for groundwater. The identification process will be performed in two separate rounds using first acute toxicity data and second chronic data:

1. If an applicable and relevant federal acute AWQC (EPA, 1986; EPA 2002a) is available for the COI, select it as the SL because it represents the most recent recommendation from EPA. If no federal AWQC is applicable or relevant, but an acute Oregon State Water Quality Standard (DEQ, 2001 [currently under revision]) is applicable and relevant, select the Oregon State Water Quality Standard as the SL.
2. If no acute AWQC or Oregon State Water Quality Standard is available, search the ECOTOX database (EPA 2002b) for freshwater toxicity values based on laboratory testing. The order of preference of alternative toxicity values will be $LC50^2$, EC50, lowest observed effect concentration (LOEC) and finally other tests where a significant difference has been measured between the control and the given test concentration. The LOECs will be selected from tests using mortality, reproduction, and growth as endpoints. Priority will be given to benthic invertebrates, water column invertebrates, and finally fish. If there is an appropriate acute toxicity value available for the COI, select it as the SL.
3. If effects-based toxicity values for the COI are not found in the ECOTOX database, evaluate whether a surrogate chemical can be used to identify an SL, based on the properties of the COI. Values based on bioaccumulation will not be considered for groundwater SLs. If there is a usable acute surrogate based on toxic mechanisms, select it as the SL.
4. If no surrogate chemical can be used, discuss the relevance of the information gap as an uncertainty.

After the identification process using acute toxicity data is completed, a similar identification process using chronic data will be performed.

5. If an applicable and relevant federal chronic AWQC (EPA, 1986; EPA 2002a) is available for the COI, select it as the SL because it represents the most recent recommendation from EPA. If no federal AWQC is applicable or relevant, but a

chronic Oregon State Water Quality Standard (DEQ, 2001 [currently under revision]) is applicable and relevant, select the Oregon State Water Quality Standard as the SL.

6. If no chronic AWQC or Oregon State Water Quality Standard is available, search the ECOTOX database (EPA 2002b) for freshwater toxicity values based on laboratory testing. If a NOEC (no observed effect concentration) based on mortality, reproductive, or growth testing is the only available value, select it as the SL. If the NOEC is less than the LC50 selected under the acute process and the same test organism is used, select it as the SL.
7. If a NOEC is not available, the acute value used under the acute evaluation will be selected and divided with an acute-to-chronic ratio (ACR) value of 10 to derive a chronic SL. Hence, the selection ranking of the toxicity values will be LC50/ACR, EC50/ACR, LOEC/ACR, and finally the other test value/ACR (a significant difference has been measured between the control and the given test concentration).

The objective of the literature search for identification of ecological SLs for groundwater is to find studies associated with chronic or acute toxicity to aquatic organisms. The ECOTOX database will be searched for toxicity reference values (TRVs) for the COIs for which applicable and relevant federal or Oregon State Quality Standards are not available. The ECOTOX database was developed and is maintained by the EPA (EPA 2002b). It consists of toxicity values found in the scientific literature for aquatic and terrestrial organisms (plants and animals). ECOTOX allows users to query the database; it reports the species tested, endpoint and effects assessed, duration of the exposure, type of exposure, effect concentration, level of significance, and the reference for the original study. Both acute and chronic studies are included in the database and endpoints include NOECs and LOECs, plus LC50s, EC50s, and other significant effect concentrations (e.g., significantly different from control but LOEC not calculated). The ECOTOX searches will be limited to freshwater, aquatic organisms, with the primary focus on toxicity to benthic invertebrates. In the selection process, preference will be given to endpoints applicable to data on taxa that are reasonably likely to be found in Portland Harbor. In cases where several values are found under the outlined ranking process, the most protective values will be selected and included in the potential groundwater SL list. If a toxicity value is not calculated for any benthic invertebrate species for a specific COI, the most protective toxicity value for water column invertebrates, and if no invertebrates, then fish species, will be included in the potential groundwater SL list.

4.2 Human Health Screening Values

Surface seeps located within human use beach areas are the only locations where potential direct human contact with groundwater may occur. The seep reconnaissance survey (GSI 2003b) identified shoreline seep locations within human use areas in the ISA. Group A upland sites were then assessed to identify locations where COIs in groundwater may be present in seeps within human use areas. Three Group A upland sites were identified in the Upland Groundwater Data Review Report (GSI 2003a) as having COIs in groundwater adjacent to or upgradient of the seeps at human use beaches. Groundwater containing COIs at these sites is confirmed to reach the river or has a reasonable potential to do so, and thus COIs are potentially present in the seep within a human use beach area. The three beaches adjacent to Group A sites where human activities may result in contact with seep water are McCormick & Baxter, Rhone Poulenc/near Railroad Bridge, and the industrial beach area near the Willbridge Bulk Fuel Facility (Chevron, Shell, Conoco/Phillips).

The seep adjacent to the McCormick and Baxter site near Willamette Cove is surrounded by a cyclone fence, which restricts public access. The seep itself is not located within the designated human use beach area in Willamette Cove. Because the seep identified in this area is not within the human use beach area and is not accessible to the public, this seep will not be included in the human health screen. In addition, remedial actions are currently underway at the upland site under regulatory agency oversight, obviating the need to conduct the human health screen for potential referral of the site to DEQ. As a result, only the seeps associated with the Rhone Poulenc and Willbridge sites will be screened for human health exposure.

The human use beach areas adjacent to the two remaining identified sites include two potential exposure scenarios that will be assessed in the baseline human health risk assessment: dockside workers (at Willbridge) and transients (at Rhone Poulenc). Site-specific factors at each beach determine which exposure scenario is applicable for that beach. Exposure assumptions for the applicable scenario(s) will be used to calculate protective, risk-based SLs for COIs identified at the corresponding upland site.

Risk-based SLs for human health will be derived through reverse calculations to determine the COI concentrations in groundwater that would result in an acceptable cancer risk or noncancer health hazard based on the appropriate exposure scenario for the human use beach where the seep occurs. SLs for groundwater associated with acceptable human health risks from dermal contact with the seep water will be calculated using the following equations:

$$\text{Screening Level, noncancer (mg/L)} = \frac{RfD \times THQ \times BW \times AT}{SA \times K_P \times EvD \times EF \times ED \times CF}$$

$$\text{Screening Level, cancer (mg/L)} = \frac{TR \times BW \times AT}{SF \times SA \times K_P \times EvD \times EF \times ED \times CF}$$

Where:

RfD	=	Reference dose (mg/kg-day)
SF	=	slope factor $(mg/kg\text{-}day)^{-1}$
THQ	=	Target hazard quotient (unitless)
TR	=	Target risk (unitless)
SA	=	Skin surface area (cm^2)
K_P	=	Dermal permeability coefficient (cm/hr)
EvD	=	Event duration (hr/event)
EF	=	Exposure frequency (events/yr)
ED	=	Exposure duration (years)
CF	=	Conversion factor (L/cm^3)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

Values for these exposure factors for the dockside worker and transient are shown in Tables 4-1 and 4-2. Values for the RfD, slope factor, and K_p are chemical-specific and will be acquired from EPA databases or other published sources.

5.0 Assessment of Potential Exposure to COIs in Groundwater

This section describes the process for assessing the potential for exposure of receptors to COIs transported to the ISA sediments via groundwater. Section 5.1 presents the selection of COI concentrations for comparison to SLs, Section 5.2 presents the benthic community exposure evaluation process, Section 5.3 presents the process for selection of two pilot study sites, and Section 5.4 presents the human health exposure evaluation.

5.1 Selection of COI Concentrations for Comparison to Screening Levels

The data set compiled as described in Section 3.2 may have multiple data points for a COI at some sites, because data from more than one well or sampling event are included. These data points may include both detected values and detection limits (for samples in which a COI was not detected). The COI concentration (based on the rules presented in Section 3.2, such as proximity to the river) that will be compared to ecological and human health SLs will be selected at each site according to the following rules:

- If all data points for the COI are detected values, the maximum detected COI concentration will be selected.
- If the data points for the COI include both detected values and detection limits (for non-detects), the maximum detected value will be selected.
- If all data points near the river for the COI are detection limits, the minimum detection limit value will be selected.

Use of a detection limit for comparison to SLs when a detected value is lacking is a conservative approach and should reduce false negatives in the screening process. However, a COI that is not detected at the monitoring point(s) near the river may not be present, and detection limits will be used in the following manner in both the ecological and human health risk screening processes:

- If the minimum detection limit is less than the screening level, the COI will not be retained as a COPC.
- If the minimum detection limit exceeds the screening level, the COI will usually be retained as a COPC. However, if the detection limit was elevated as a result of dilution or due to another data quality issue, the COI will not be retained as a COPC. The data point will also be evaluated to determine if the COI might reasonably be present at the point of exposure based on the following fate and transport factors: a) the distance of the monitoring point from the nearest detected concentration of the COI, b) the distance of the river from the monitoring point, c) physiochemical properties of the COI, and d) hydrogeologic properties of the water-bearing zones that affect COI migration. If this evaluation indicates the COI is unlikely to reach the river or a surface seep in a human use beach area, the COI will not be retained as a COPC.

5.2 Application of Ecological SLs to Groundwater COIs

As discussed in Section 2, four generalized transport scenarios were identified for groundwater in the ISA. The approach to evaluating the potential for exposure of the

benthic community may be different for each of these scenarios and is discussed in the following sections.

5.2.1 Groundwater containing COIs from an upland source flows through sediments impacted by a different source or release

The proposed approach for assessing exposure associated with this transport scenario is presented in Figure 2. Groundwater COIs found to exceed the SL will be assessed. There are two possible assessment paths for groundwater COIs that exceed an SL, depending on whether the COI is likely to sorb to sediment particles.

If the COI is likely to sorb to sediment particles (an evaluation of this potential will be conducted based on a literature review and technical discussions), then the sediment chemistry predictive model being developed for assessing benthic risks (see Appendix C of the RI/FS WP) can be used to determine whether the surface sediment presents a risk to the benthic community. If the predictive model or direct whole-sediment toxicity data available for the location do not indicate the potential for toxicity, then no further assessment of groundwater as a pathway is warranted. If the predictive model does predict whole-sediment toxicity, then the results of the ecological risk assessment can be used to resolve whether remediation of sediment will be required. If remediation is required, there may also be a need for source control measures to be evaluated by DEQ. The determination of whether groundwater source control measures are necessary and the assessment strategy is outlined in the Portland Harbor Joint Source Control guidance document (currently under development). Risk management decisions based on risks posed by the COIs in the groundwater will be based on the existence of complete pathway(s) to the river, exceedance of water quality screening criteria, documented linkage between groundwater and sediment contamination, and the results of the in-water risk assessments demonstrating unacceptable risk to in-water receptors.

If the COI in groundwater is not likely to sorb to sediment particles (e.g., volatile organic compound), then the use of whole-sediment chemistry alone in the sediment chemistry predictive model may not adequately represent all potential for toxicity and additional assessment of the potential impact to benthos will be required. If the predictive model does predict whole-sediment toxicity, then the results of the ecological risk assessment can be used to resolve whether remediation of sediment will result in a reduction of risk. If the model does not predict whole-sediment toxicity, the relative contribution of the groundwater pathway and other sources of COIs in porewater will be evaluated to help determine the potential for unacceptable risk. The need for additional site-specific evaluations, and the specific types of evaluation processes for each site will be determined in cooperation with EPA, based on results of pilot studies described in Section 5.3 and other results from the RI and FS

investigations. The specific location(s) and methodology(s) for any such evaluation will be documented in a Technical Memorandum. At this time, the LWG cannot recommend that locations with significant mixture of groundwater and other contaminant sources be selected for the pilot studies described in Section 5.3, because confounding factors would make it difficult to characterize the specific effect of groundwater on porewater. However, selection of sites will be discussed with EPA before sampling recommendations are made.

5.2.2 Surface seepage of groundwater containing COIs

Surface seeps are not likely to result in significant direct exposure to ecological receptors. Any potential benthic exposure will be captured under the sediment or surface water pathway evaluation. Other wildlife species that may have direct contact with seeps are not likely to have significant exposure. For ecological species, in summary:

- there is only very limited duration of exposure, particularly for birds and mammals.
- feathers or fur limit any exposure that may incidentally occur,
- ingestion of water in general, and of seeps in particular, even if exhibiting high concentrations of COIs, is a minor pathway and will not likely influence the overall risk estimate (reduce it or increase it), and
- if NAPL or other obvious sheen is observed, this will be addressed using the Portland Harbor Joint Source Control guidance document (currently under development). Therefore, the identification of the potential for acute exposure will be addressed through source control.

5.2.3 Groundwater containing COIs from an upland source that flows through sediment not impacted by a separate source or release

Depending on the physicochemical characteristics of the COI, this transport scenario will be addressed using the predictive model or is already addressed under the scenario described in Section 5.2.1:

1. For COIs that are likely to sorb to sediments, the COIs are likely to be adequately characterized through bulk sediment chemistry tests, and risks will be addressed through the use of the predictive model.
2. For COIs whose physicochemical characteristics would not result in sorption to sediments, the COIs may not be detected in sediment chemistry tests. Instances where COIs in the groundwater do not sorb and may cause an adverse benthic

impact are addressed in Section 5.3.

5.2.4 Clean groundwater flowing through contaminated sediments (no upland chemical source)

In this transport scenario, groundwater is not an exposure pathway of concern because the groundwater is clean. Therefore, no groundwater analysis is necessary. Benthic risks from contaminated sediments with no upland groundwater source will be evaluated using the sediment chemistry predictive model being developed and other potential sources upland, over-water, or upstream will be investigated.

5.3 Selection of Two Pilot Study Sites

For those COIs in groundwater that do not sorb and may cause adverse benthic impact, two pilot study sites will be selected from the Group A sites in cooperation with EPA. To select the sites from those available, the sites will be ranked in accordance to exceedances of first the ecological acute and then the chronic SLs, with the primary focus on volatile organic compound (VOC) and semivolatile organic compounds (SVOC) exceedances. The sites will then be evaluated, starting with the highest ranked, based on factors such as other sources of contamination in or near the biologically active zone, and fate and transport properties of the COIs. The goal of the evaluation process is to find two sites with measured COI concentrations in the groundwater exceeding the SLs and potentially discharging to the area of the river not impacted by a separate source. Additional porewater sampling and analysis, or other suitable sampling and analyses, will be performed in the biologically active zone at these two sites. Porewater will be collected using techniques agreed to with EPA and DEQ and analyzed for chemicals identified by the screening process. The porewater chemistry data will be compared to the acute and chronic SLs and results evaluated within the baseline risk assessment.

5.4 Application of Human Health Screening Levels to Groundwater COIs

The only groundwater transport scenario relevant for potential direct human contact is surface seepage of groundwater containing COIs. As noted previously, COIs present in surface seeps may pose risk to human health through dermal contact, if contact with seep water occurs during activities within human use beach areas. As explained in Section 4.2, seeps present in the human use beach areas adjacent to Rhone Poulenc near the Railroad Bridge and at the Willbridge Bulk Fuel Facility will be evaluated using human health risk-based SLs. The approach for application of the SLs to groundwater COIs is shown in Figure 3.

As shown in Figure 3, the first step is selection of representative groundwater COI

concentrations as described in Section 5.1. The selected COI concentrations will be compared to the SLs developed as described in Section 4.2. If selected COI concentrations at a given site do not exceed SLs, no further analysis will be needed at the site. If concentrations of any COIs exceed SLs, those COIs that exceed will be selected as groundwater COPCs.

If groundwater COPCs are identified through the screening process at either or both of the two human use beaches identified above, samples of seep water will be collected and analyzed for those COPCs using the same analytical methods used to evaluate direct contact with surface water. Analytical methods and laboratory detection limits are listed in the Quality Assurance Project Plan Addendum (SEA 2003). If COPCs in the seep samples do not exceed SLs, no further analysis will be conducted by the LWG for the site. COPCs that exceed the SLs will be assessed for human health risk under the applicable exposure scenario for that beach in the baseline human health risk assessment. The associated upland site will also be referred to DEQ for further evaluation.

NAPL is not present at either of the two Group A sites where COIs may be present in seeps at human use beaches. Therefore, NAPL will not be considered further for the human health risk assessment.

6.0 Deliverables

The screening processes differ significantly for ecological and human health risk from groundwater COIs, and therefore will be conducted separately. Results of each screening process will be presented in a separate technical memorandum and incorporated into the baseline ecological or baseline human heath risk assessment. The technical memorandum will present the SLs, the COI concentrations selected or developed for comparison, and the results of the comparison of COI concentrations to SLs. If necessary, the rationale for selection of sampling locations for porewater and seep water will be described and will form the basis for additional sampling to be proposed for Round 2B. The approach for incorporating these results into the baseline ecological and human health risk assessments will be briefly described.

7.0 References

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